(19) Europäisches Patentamt
Europ an Patent Offic
Office eur péen des br vets

(11) Publication number: **0 342 169 A2**

# (12) EUROPEAN PATENT APPLICATION

(21) Application number: **89830205.4**

(51) Int. Cl.[4]: **B 01 D 53/36**

(22) Date of filing: **10.05.89**

(30) Priority: **11.05.88 JP 114388/88**

(43) Date of publication of application:
**15.11.89 Bulletin 89/46**

(84) Designated Contracting States: **DE FR GB IT**

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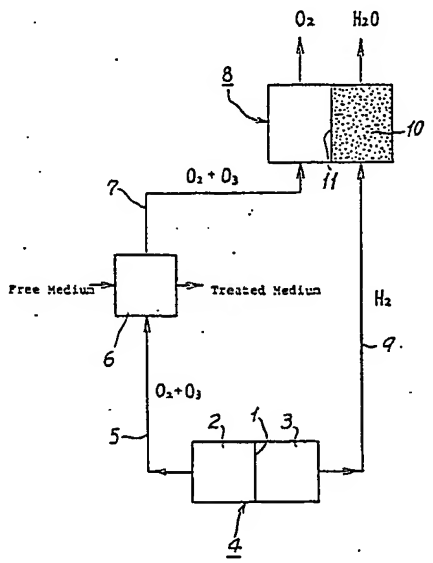
## (54) Electrolytic ozonizer and method of decomposing ozone-containing waste gas using said ozonizer.

(57) The present invention is directed toward an electrolytic ozonier for treating ozone-containing waste gas and a method of treating ozone-containing waste gas using the ozonier, wherein the method includes evolving oxygen and ozone in an anode compartment of an electrolytic cell by electrolysis of water while evolving hydrogen in a cathode compartment; directing the evolved hydrogen into a waste gas treating section that contains a waste gas decomposition catalyst so as to convert the hydrogen to a harmless form by means of the catalyst; bringing the oxygen and ozone into contact with a medium to be treated in an ozone contactor so as to treat the medium; and subsequently directing waste gas containing oxygen and ozone produced as a result of treatment of the medium into the waste gas treating section where they are brought into either direct or indirect contact with the catalyst so that the ozone in the waste gas is converted into a harmless form.

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medium into said waste gas treating section where they are brought into either direct or indirect contact with said catalyst so that the ozone in said waste gas is converted to harmless form.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a flowchart showing the outline of procedures for treating a medium and ozone-containing waste gas by the method of the present invention;

Fig. 2 is a longitudinal section showing an example of the waste gas treating section of the electrolytic ozonizer of the present invention; and

Fig. 3 is a longitudinal section showing another example of the waste gas treating section.

## DETAILED DESCRIPTION OF THE INVENTION

In their efforts to solve the problems of conventional electrolytic methods of ozone generation, the present inventors noted the fact that the heat of conversion (combustion or oxidation) of hydrogen gas evolved in the cathode compartment of an electrolytic ozonizer can be effectively used to decompose ozone. The principles of the method and apparatus of the present invention are based on this fact and are characterized in that a waste gas which contains ozone generated by electrolysis and which results from the treatment of a medium is treated simultaneously with hydrogen gas, also generated by electrolysis, without the use of two different kinds of catalysts or two types of gas connecting apparatuses.

Hydrogen gas evolved in the cathode compartment of an electrolytic ozonizer can explode in a closed space if it is immediately released into an air atmosphere. Therefore, it is converted to non-hazardous water by conversion with a catalyst. This reaction is expressed by $H_2 + 1/2O_2 \rightarrow H_2O$ and generates heat of as much as 68.3 kcal. The temperature of combustion, which varies with the type of catalyst used or the amount of hydrogen evolved, will reach 200 - 500°C under normal conditions of burning (i.e., hydrogen is supplied into 50 mℓ of catalyst at a flow rate of 5 mℓ/sec.) If the ozone-containing waste gas is heated at this temperature, ozone will be decomposed in a few seconds to be converted to oxygen ($2O_3 \rightarrow 3O_2$). If, alternatively, the ozone-containing waste gas is supplied into the hydrogen gas, the ozone in the waste gas reacts with hydrogen to be converted to water. These principles are used in the preset invention, in which ozone-containing waste gas is directed into a hydrogen gas conversion catalyst itself or to its neighborhood, so that the ozone in the waste gas is either decomposed by the heat of conversion (combustion) of hydrogen gas or reacted with the hydrogen gas to be converted to water.

The outline of the procedures for treating a medium and ozone-containing waste gas are shown in flowchart in Fig. 1. The basic operation of the method and apparatus of the present invention are described hereinafter with reference to Fig. 1.

When water is electrolyzed in an electrolytic cell 4 consisting of an anode compartment 2 and a cathode compartment 3 separated by a diaphragm 1, a gaseous mixture of ozone and oxygen is evolved in the anode compartment 2 whereas hydrogen gas evolved in the cathode compartment 3. The mixture of ozone and oxygen gases flows through a conduit 5 into an ozone contactor 6 where it makes contact with a medium to be treated such as municipal water. The waste gas having a reduced ozone concentration flows through a conduit 7 into a waste gas decomposing section 8. The hydrogen gas evolved in the cathode compartment 3 flows through a conduit 9 into that portion of the waste gas decomposing section 8 which is filled with a hydrogen conversion catalyst 10. With the aid of the catalyst 10, the hydrogen gas is burnt to be converted to water vapor. The heat of combustion is transmitted through a diaphragm 11 to decompose the ozone in the waste gas, thereby generating oxygen. The structure of the waste gas decomposing section 8 is not limited to the one shown in Fig. 1 and, as will be described later in this specification, this section may be so designed that the ozone-containing waste gas and the hydrogen gas are mixed to undergo direct reaction with each other.

The electrolytic cell 4 for ozone generation in the present invention may be of any conventional type, such as a dimensionally stable anode separated from a nickel cathode by a fluorinated ion-exchange membrane, or a solid polymer electrolyte (SPE) composed of a fluorinated ion-exchange membrane coated on both sides with an electrode active material such as a lead dioxide power or a platinum powder.

When water is electrolyzed using the electrolytic cell described above, oxygen gas containing a small amount of ozone is evolved in the anode compartment whereas hydrogen gas is evolved in the cathode compartment. The ozone-containing oxygen gas flows through a suitable conduit into an ozone contactor where it makes contact with a medium to be treated, such as municipal water to be disinfected. The conduit connecting the anode compartment with the ozone contactor is preferably sealed to prevent contamination by foreign matter. The ozone-containing gas, an ozone concentration of which may reach to $10^5$ ppm, is corrosive, so that the conduit is made of a corrosion-resistant material, preferably titanium or glass.

The ozone-containing waste gas resulting from the ozone treatment of the medium contains from about 0.1 to $10^4$ ppm of ozone and is also corrosive, so that it is preferably directed to the waste gas decomposing section through a titanium conduit.

Leakage of the hydrogen gas evolved in the cathode compartment of the electrolytic cell may cause explosion, so that it is preferably directed into the waste gas decomposing section through a sealed conduit.

ing waste gas as well as the hydrogen gas evolved in the cathode compartment are introduced into a single waste gas decomposing section, where ozone is converted to harmless oxygen and the hydrogen gas to water vapor.

The waste gas decomposing section is filled with nothing but a hydrog n conversion catalyst. However, when water vapor is produced by combustion of hydrogen, a sufficient amount of heat to convert ozone to oxygen is released so that ozone can be rendered harmless in an indirect way without employing any separate ozone decomposing section filled with an ozone decomposition catalyst. If desired, the ozone-containing waste gas and hydrogen gas may be introduced, either simultaneously or in admixture, into the waste gas decomposing section, so that water vapor is produced as a result of reaction between hydrogen, oxygen and ozone. In this method, too, ozone can be rendered harmless without using two kinds of catalyst or decomposing section.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one of ordinary skill in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

## Claims

1. An electrolytic ozonizer comprising:
an electrolytic cell in which oxygen and ozone are evolved in an anode compartment by electrolysis of water, and hydrogen is evolved in a cathode compartment;
a waste gas decomposing section being connected to said anode compartment of said electrolytic cell and being connected to said cathode compartment, said waste gas decomposing section contains a waste gas decomposition catalyst;
an ozone contactor for treating a medium, said contactor being interposed between said anode compartment and said waste gas decomposing section;
wherein ozone-containig waste gas which is produced as a result of treatment of a medium in said ozone contactor and said hydrogen gas evolved in said cathode compartment, are brought into either direct or indirect contact with said catalyst to be converted to a harmless form.

2. The electrolytic ozonizer according to claim 1, wherein said waste gas decomposing section comprises a hollow member filled with a hydrogen conversion catalyst, said hollow member comprises a conduit for passage of said ozone-containing waste gas wherein said conduit penetrates said hollow member transversely in such a way that said ozone-containing waste gas makes indirect contact with said catalyst via the wall of said conduit.

3. The electrolytic ozonizer according to claim 1, wh rein said waste gas decomposing section comprises a hollow member filled with a hydrogen conversion catalyst, said hollow member comprises a conduit for passage of said ozone-containing waste gas wherein said conduit is inserted into said hollow member in such a way that said ozone-containing waste gas makes direct contact with said catalyst.

4. A m thod of treating waste gas comprising the steps of:
evolving oxygen and ozone in an anode compartment of an electrolytic cell by electrolysis of water while evolving hydrogen in a cathode compartment;
directing the evolved hydrogen into a waste gas treating section that contains a waste gas decomposition catalyst so as to convert said hydrogen into a harmless form by means of said catalyst;
bringing said oxygen and ozone into contact with a medium to be treated in an ozone contactor so as to treat said medium; and
directing waste gas containing oxygen and ozone produced as a result of treatment of said medium into said waste gas treating section where they are brought into either direct or indirect contact with said catalyst so that the ozone in said waste gas is converted to a harmless form.

5. The method of treating waste gas according to claim 4, wherein said waste gas is brought into direct contact with said catalyst so as to convert ozone to water.

6. The method of treating waste gas according to claim 4, wherein said waste gas is brought into indirect contact with said catalyst so as to decompose ozone with heat generated by conversion of said hydrogen, to produce oxygen. either direct or indirect contact with said catalyst so that the ozone in said waste gas is converted to a harmless form.

5. The method of treating waste gas according to claim 4, wherein said waste gas is brought into direct contact with said catalyst so as to convert ozone to water.

6. The method of treating waste gas according to claim 4, wherein said waste gas is brought into indirect contact with said catalyst so as to decompose ozone with heat generated by conversion of said hydrogen, to produce oxygen.

FIG. 2

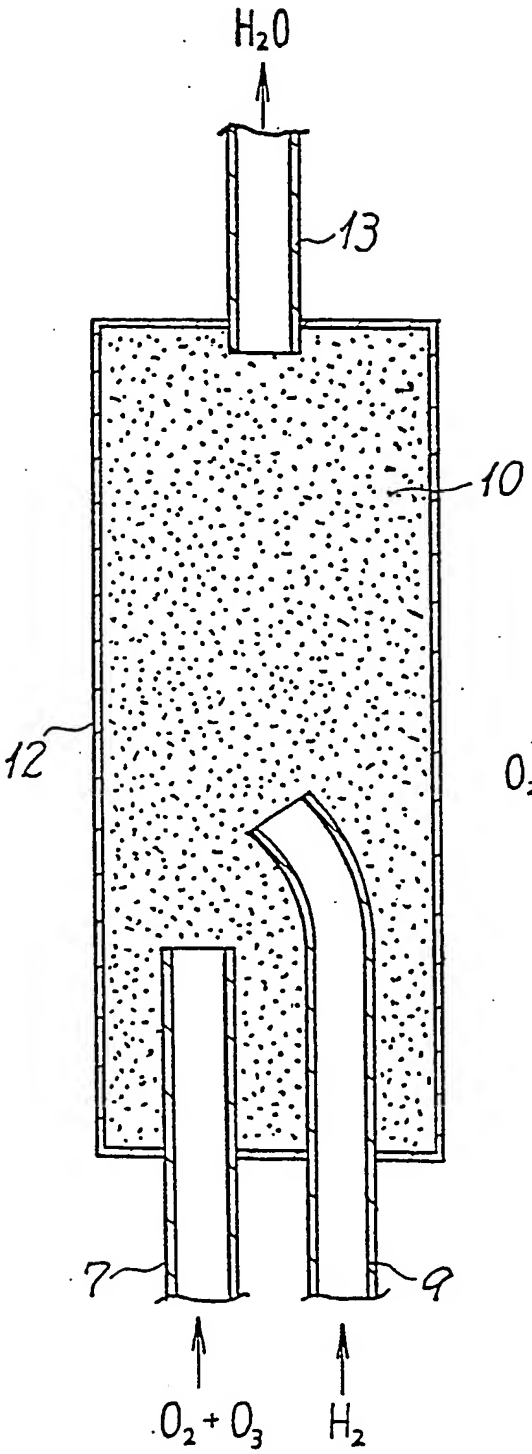


FIG. 3